

5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

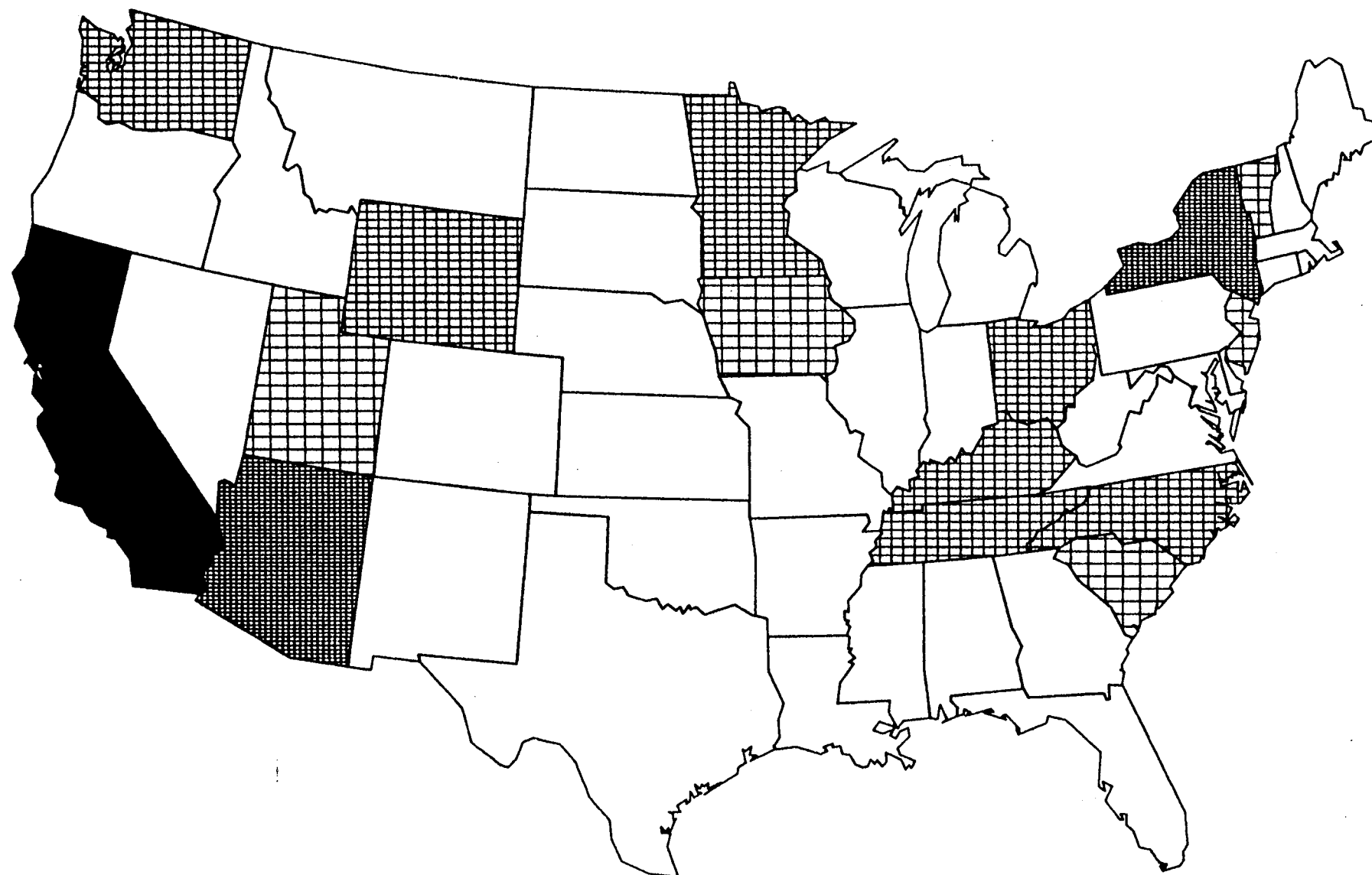
Ethylene glycol is released to the environment in manufacturing and processing waste streams and as the result of disposal of industrial and consumer products containing this compound. The major sources of releases are from the disposal of used antifreeze and de-icing solutions. Upon release to the environment, the compound is expected to partition to and be transported in surface water and groundwater. Because of its high solubility in water and lack of adsorption or partitioning into soils, ethylene glycol will have a high mobility in soil and potential to leach into groundwater. Ethylene glycol is rapidly degraded in all environmental media and it does not persist or bioaccumulate. Biodegradation is the most important transformation process in surface waters and soils. Assuming first order kinetics, the half-life for ethylene glycol in water is estimated to be 2-12 days under aerobic and 8-48 days under anaerobic conditions while the half-life in soil is estimated to be 0.2-0.9 days. Aerosols or vapors released to the atmosphere readily undergo photochemical oxidation with an estimated half-life of 0.3-3.5 days. Little information was found on concentrations of ethylene glycol in any environmental media.

The most important routes of exposure to ethylene glycol for members of the general population are dermal contact with products containing this compound (antifreeze and hydraulic fluids) and intentional or accidental oral exposures. In occupational settings, workers are exposed via dermal and possibly inhalation contact in applications involving the heating or spray application of fluids containing this compound.

Ethylene glycol has been identified in at least 34 of 1,416 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (HazDat 1995). However, the number of sites evaluated for ethylene glycol is not known. The frequency of these sites within the United States can be seen in Figure 5-1.

Propylene glycol is released to the environment in manufacturing and processing waste streams and as the result of disposal of industrial and consumer products containing this compound. The major sources of releases are from the use and disposal of this compound in de-icing solutions. Because of its solubility in water and lack of adsorption and partitioning to soils, propylene glycol will have a

FIGURE 5-1. FREQUENCY OF NPL SITES WITH ETHYLENE GLYCOL CONTAMINATION *



FREQUENCY



1 SITE
2 SITES
3 SITES



2 SITES
9 SITES

*Derived from HazDat 1995

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high mobility in soil and potential to leach into groundwater. Upon release to the environment, the compound is expected to partition to and be transported in surface water and groundwater. Propylene glycol is rapidly degraded in all environmental media; it is not expected to persist or bioaccumulate in aquatic organisms. Biodegradation is the most important transformation process in surface waters and soils. Assuming first order kinetics, the half-life of propylene glycol in water is estimated to be 1-4 days under aerobic and 3-5 days under anaerobic conditions. The half-life of propylene glycol in soil is expected to be equal to or slightly less than that for water. Vapors released to the atmosphere readily undergo rapid photochemical oxidation via reaction with hydroxyl radicals with an estimated half-life of 0.8 days. Little information was found on concentrations of this compound in any environmental media. Propylene glycol is a Generally Recognized as Safe (GRAS) food additive that is widely used in food and tobacco products, pharmaceuticals, and cosmetics.

The most important routes of exposure to propylene glycol for members of the general population are ingestion and dermal contact with products containing this compound. The general public also may be exposed to small amounts of propylene glycol released from newly installed carpet with polyvinyl backing. In occupational settings, workers are exposed via dermal contact and possibly inhalation in applications involving the heating or spray application of fluids containing this compound.

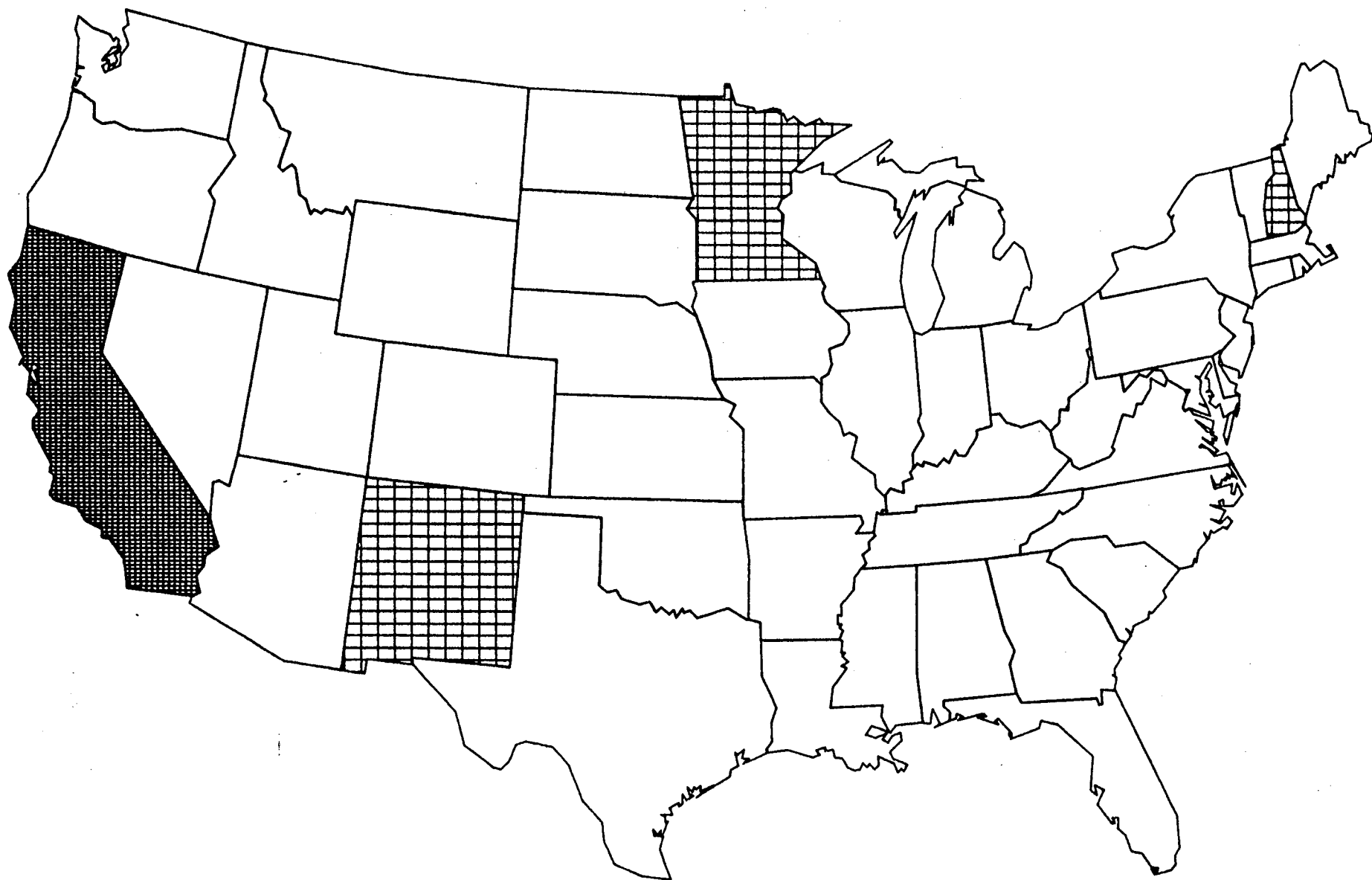
Propylene glycol has been identified in at least 5 of 1,416 hazardous waste sites that have been proposed for inclusion on the EPA NPL (HazDat 1995). However, the number of sites evaluated for propylene glycol is not known. The frequency of these sites within the United States can be seen in Figure 5-2.

5.2 RELEASES TO THE ENVIRONMENT


Releases of ethylene glycol are required to be reported under SARA Section 313; consequently data are available for this compound in the 1993 Toxic Release Inventory (EPA 1995c). There are at least 34 NPL hazardous waste site where ethylene glycol has been identified in some environmental media (HazDat 1995).

Releases of propylene glycol are not required to be reported under SARA Section 313; consequently there are no data for this compound in the 1993 Toxic Release Inventory (EPA 1995c). There are at

FIGURE 5-2. FREQUENCY OF NPL SITES WITH PROPYLENE GLYCOL CONTAMINATION *



FREQUENCY  1 SITE
*Derived from HazDat 1995

 2 SITES

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least 5 NPL hazardous waste site where propylene glycol has been identified in some environmental media (HazDat 1995).

5.2.1 Air

The estimated releases of 10 million pounds of ethylene glycol to the atmosphere accounted for about 55% of the estimated total environmental releases from 1,296 domestic manufacturing and processing facilities in 1993 (TR193 1995). These releases are summarized in Table 5-1. On a nationwide basis, the total amount of ethylene glycol released to the atmosphere appears to have changed very little during the period 1990-93 (as shown in Table 5-2). The data from the Toxic Release Inventory (TRI) listed in Tables 5-1 and 5-2 should be used with caution, however, since only certain types of facilities are required to report (EPA 1995c). This is not an exhaustive list.

Ethylene glycol has been detected in air samples collected at four hazardous waste sites where it was detected in some environmental media (HazDat 1995). During the application of de-icing solutions to aircraft, an estimated 49-80% of de-icing solutions containing both ethylene glycol and propylene glycol are released on airport runway aprons. The remainder is retained on the aircraft or is immediately dispersed to the air (Sills and Blakeslee 1992); however, releases to the atmosphere are limited by its low vapor pressure (Ware 1988).

Little information was found regarding the release of propylene glycol to the atmosphere. Propylene glycol used as a solvent in paints, inks, and coatings will slowly volatilize to the atmosphere (EPA 1987a). During the application of de-icing solutions to aircraft, an estimated 49-80% of de-icing solutions containing both ethylene glycol and propylene glycol are released on airport runway aprons. The remainder is retained on the aircraft or is immediately dispersed to the air (Sills and Blakeslee 1992); however, release to the atmosphere is expected to be limited by the compound's low vapor pressure.

There is no information on releases of propylene glycol to the atmosphere from domestic manufacturing and processing facilities because these releases are not required to be reported (EPA 1995c). Propylene glycol has not been detected in air samples collected at any hazardous waste sites where it was detected in some environmental media (HazDat 1995).

Table 5-1. Releases to the Environment from Facilities That Manufacture or Process Ethylene Glycol

State ^b	Number of facilities	Range of reported amounts released in pounds per year ^a						
		Air	Water	Land	Underground Injection	Total environment ^c	POTW transfer	Off-site waste transfer
AK	1	250	8000	5	0	8255	0	0
AL	16	0-157000	0-4200	0-1400	0	0-157000	0-1246	0-30130
AR	17	0-28552	0-660	0	0	0-28552	0-1300	0-170000
AZ	8	0-765	0	0	0	0-765	0-75000	0-90900
CA	85	0-17005	0-178204	0-28545	0-1393	0-178204	0-178204	0-270000
CO	8	0-281	0-1700	0	0	0-1717	0-33000	0-119815
CT	9	0-2200	0-16400	0	0	0-16400	0-1600	0-4530
DE	10	0-111	0-82	0	0	0-111	0-27789	0-22000
FL	30	0-68000	0-1521	0-5200	0-750	0-68000	0-21000	0-26950
GA	51	0-35329	0-7900	0-1000	0	0-35329	0-69000	0-1307215
IA	18	0-3198	0-60	0	0	0-3198	0-4438600	0-38990
ID	4	0-42000	0	0	0	0-42000	0-29600	0-18700
IL	98	0-49000	0-22000	0-5300	0	0-54610	0-57500	0-136743
IN	48	0-19040	0-234098	0-17199	0	0-234098	0-48000	0-16446044
KS	12	0-34320	0-20000	0	0	0-54320	0-15000	0-135262
KY	36	0-33000	0-25206	0-13623	0	0-33000	0-8500	0-87000
LA	32	0-194000	0-32000	0-447		0-266218	0-750	0-37859
MA	17	0-10470	0-4565	0	0	0-10470	0-84493	0-42581
MD	17	0-72900	0-9	0	0	0-72900	0-40400	0-150958
ME	10	0-10981	0-5200	0-240523	0	0-251504	0-12500	0-23016
MI	52	0-18000	0-5400	0-410	0-750	0-18000	0-72200	0-144600
MN	16	0-24170	0-3300	0	0	0-24170	0-250000	0-13539
MO	32	0-12000	0-35	0-400	0	0-12000	0-39000	0-73300
MS	10	0-2000	0-43000	0-5	0	9-45000	0-5	0-140000
MT	4	0-500	0-9500	0	0	0-9530	0	0-250
NC	52	0-380000	0-13192	0-3100	0	0-380025	0-41700	0-29602040
ND	4	0-250	0	0	0	0-250	0-620	0-1500
NE	8	0-500	0-250	0-250	0	0-500	0-750	0-750
NH	5	0-1800	0	0	0	0-1800	0-9300	0-15000
NJ	59	0-5723	0-529	0	0	0-5723	0-1224297	0-82954

Table 5-1. Releases to the Environment from Facilities That Manufacture or Process Ethylene Glycol

State ^b	Number of facilities	Range of reported amounts released in pounds per year ^a						
		Air	Water	Land	Underground Injection	Total environment ^c	POTW transfer	Off-site waste transfer
NM	4	220-2521	0	0-200	0	420-2521	0-184530	0-64549
NV	1	10	0	0	0	10	0	0
NY	35	0-20760	0-8840	0-250	0	0-20760	0-55000	0-59250
OH	93	0-189327	0-152022	0-39000	0	0-189327	0-79000	0-217000
OK	13	0-18000	0	0-250	0	0-18000	0-13900	0-8379
OR	12	0-22400	0-750	0	0	0-22400	0-120000	0-1700
PA	56	0-69539	0-24000	0-250	0	0-69539	0-13819	0-130417
PR	18	0-10200	0	0-250	0	0-10200	0-17452	0-128000
RI	7	0-15472	0-19964	0	0	0-21356	0-12400	0-3827459
SC	54	0-185000	0-11789	0-2400	0	0-185140	0-104250	0-30971777
TN	36	0-131000	0-75000	0-225000	0	0-232255	0-77000	0-200000
TX	106	0-3165000	0-7700	0-57000		0-8765000	0-1131000	0-2423611
UT	6	0-3147	0	0-17550	0	0-17550	0-47537	0
VA	25	0-496479	0-1338	0-250	0	0-496479	0-1565885	0-4548200
WA	14	0-5262	0	0	0	0-5262	0-250	0-8673
WI	32	0-77500	0-4530	0-600000	0	0-600000	0-82400	0-70750
WV	12	0-1350422	0-19846	0-457	0	3-1350925	0-110230	0-10252484
WY	3	0-74	0	0	0-18966	72-18966	0	0-1104

Source: TRI93 1995

POTW = Publicly owned treatment works

^a Data in TRI are maximum amounts released by each facility.^b Post office state abbreviations used^c The sum of all releases of the chemical to air, land, water, and underground injection wells by a given facility

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Table 5-2. National Ethylene Glycol Emissions in Pounds per Year in Different Environmental Media During 1990–1993

Medium	Year			
	1990	1991	1992	1993
Air	10,970,217	10,803,502	10,251,162	10,224,243
Water	2,754,760	2,313,490	1,326,208	1,162,522
Underground injection	5,809,297	3,654,273	4,923,321	5,943,528
Land	987,625	908,417	908,417	1,282,769
Total emissions	20,521,899	17,679,682	17,185,279	18,613,062
POTW	15,958,825	19,321,608	19,775,302	15,062,080
Offsite	11,284,651	102,777,473	117,787,794	133,894,430

Source: TRI90 1992; TRI91 1993; TRI92 1994; TRI93 1995

POTW = Publicly owned treatment works

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5.2.2 Water

Ethylene glycol is released to surface waters in waste water from production and processing facilities, from spills, in runoff (e.g., through the use of the compounds as de-icing fluids), and in the disposal of used antifreeze (Ware 1988). Ethylene glycol concentrations up to 19,000 mg/L (ppm) were detected in storm water runoff at the Salt Lake City Airport in Utah, and airport runoff was found to contain up to 3,100 mg/L (ppm) at the Toronto International Airport in Canada and up to 5,050 mg/L (ppm) at the Denver Airport in Colorado (Sills and Blakeslee 1992). Ethylene glycol was detected, but the concentration was not quantified in effluents from a chemical plant in Brandenburg, Kentucky (EPA 1976).

According to the Toxics Release Inventory (TRI), an estimated 1.2 million pounds of ethylene glycol were released to surface waters in 1993 from 1,296 domestic manufacturing and processing facilities accounting for 6% of the estimated total environmental releases (TR193 1995). An additional 15 million pounds were released in effluents to publicly owned treatment works (POTW) (TR193 1995). During the period 1990-93, the nationwide release of ethylene glycol to surface water from manufacturing and processing facilities appears to have declined significantly (by more than 50%) from 2.8 million pounds in 1990 to 1.2 million pounds in 1993, while the trend in the total discharge to POTWs during the same period appears to have remained relatively constant with slightly higher discharges (approximately 20 million pounds) being sent to POTWs in 1991 and 1992 (see Table 5-2). As a result of secondary treatment processes in POTWs, only a small portion (0-12%) of the ethylene glycol that enters POTWs is subsequently released to surface waters (Howard et al. 1991).

Groundwater samples collected from a perched water table at the Ottawa Airport in Canada contained 415 mg/L (ppm) of ethylene glycol (Sills and Blakeslee 1992). Ethylene glycol also has been detected in groundwater samples collected at 7 hazardous waste sites where it was detected in some environmental media (HazDat 1995).

Propylene glycol is released to surface waters in waste water from production and processing facilities and from spills and in runoff (e.g., through the use of the compound in de-icing fluids). Propylene glycol concentrations up to 19,000 mg/L (ppm) were detected in storm water runoff at the Salt Lake City Airport in Utah (Sills and Blakeslee 1992). Propylene glycol was detected, but the concentration was not quantified in effluents from a chemical manufacturing plant in Memphis, Tennessee (EPA

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1976). Propylene glycol may also be released to surface waters as a metabolite of propylene glycol dinitrate which is a military propellant found in waste water streams from munitions facilities (EPA 1979, 1987a; Kaplan et al. 1982; Walker and Kaplan 1992, 1992).

There is no information in the Toxic Release Inventory (TRI) on releases of propylene glycol to surface or groundwater from domestic manufacturing and processing facilities because these releases are not required to be reported (EPA 1995c).

Groundwater samples collected from a perched water table at the Ottawa Airport in Canada contained 4 mg/L (ppm) of propylene glycol (Sills and Blakeslee 1992). Propylene glycol also has been detected in groundwater samples collected at two hazardous waste sites where it was detected in various environmental media (HazDat 1995).

5.2.3 Soil

The major sources of ethylene glycol releases to soil are from the disposal of used antifreeze fluids and de-icing fluids containing the compound (EPA 1979, 1987a; Ware 1988). Smaller amounts of ethylene glycol are released to soil from the disposal of vehicular hydraulic brake fluids (EPA 1979, 1987a). Ethylene glycol may also be released to soil via natural processes associated with the metabolism of ethylene by plants (Blomstrom and Beyer 1980).

According to TRI, an estimated total of 1.3 million pounds of ethylene glycol was released to soils from 1,296 domestic manufacturing and processing facilities accounting for almost 7% of total environmental releases in 1993 (TRI93 1995). An additional 5.9 million pounds, constituting about 32% of the total environmental emissions, were released by underground injection (TR193 1995). Nationwide release data for the period from 1990 to 1993, shown in Table 5-2, indicate that the amount of ethylene glycol released to land has fluctuated greatly. The amount of ethylene glycol released via underground injection has also fluctuated during this period with higher releases reported in 1990 and 1993 and significantly lower releases in both 1991 and 1992.

Ethylene glycol has been detected (at an unspecified concentration) in a soil sample collected at an NPL hazardous waste site where it was detected in various environmental media (HazDat 1995).

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The major sources of propylene glycol releases to soil are the disposal of used antifreeze fluids and de-icing fluids containing the compounds (EPA 1979, 1987a).

There is no information in the TRI on releases of propylene glycol to soil from domestic manufacturing and processing facilities because these releases are not required to be reported (EPA 1995c). Propylene glycol has not been detected in any soil samples collected at hazardous waste sites although it has been detected in other environmental media (HazDat 1995).

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

Ethylene glycol has a low vapor pressure (0.06 mm Hg at 20 °C) and is miscible with water (see Table 3-2). If released to the atmosphere (e.g., as vapors generated at elevated temperatures), ethylene glycol should exist almost entirely in the vapor phase (Eisenreich et al. 1981). The high solubility of ethylene glycol in water ensures that at least partial removal of the compound will occur by wet deposition. Therefore, upon release to the environment, the compound is expected to be transported primarily in aqueous media (EPA 1979). The low Henry's law constant value for this compound (2.34×10^{-10} atm·m³/mole; see Table 3-2) suggests that releases to surface water will not partition to the atmosphere via volatilization (Simmons et al. 1976; Thomas 1990). Adsorption to sediment or soil particulates is also not expected to be significant on the basis of the low K_{oc} value (see Table 3-2). Based on the low K_{oc} value (see Table 3-2), ethylene glycol is expected to have a very high mobility in soil and could leach into groundwater (Swann et al. 1983).

The low octanol/water partition coefficient (K_{ow}) values of 0.256 suggests that bioconcentration and biomagnification of ethylene glycol are not likely to occur. Laboratory testing with this compound confirms insignificant bioconcentration in algae and fish (Freitag et al. 1985). The bioconcentration factor (BCF) for ethylene glycol in a fish (Golden ide) was 10 after 3 days of exposure and was 190 after 1 day of exposure in the algae *Chlorella fusca*. The uptake of ethylene glycol by crawfish (*Procambarus* sp.) was found to be dependent upon the aqueous concentration, but the concentrations in various crayfish tissues were always less than the concentrations in water (Khouri et al. 1993). The BCF in gills, muscle, gastrointestinal tracts, and hepatopancreas of the crawfish were <1 even at the highest water concentration. When transferred to freshwater, the depuration of ethylene glycol was

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complete in 5 days for crayfish exposed to 50 µg/mL (ppm) and in 6 days for those exposed to 200 and 1,000 µg/mL (ppm) (Khoury et al. 1993).

Ethylene glycol is expected to be highly mobile, particularly in moist soils, and it may leach into groundwater upon release to surface soils. In laboratory studies, ethylene glycol was found to percolate rapidly through soil columns with little or no adsorption (LDOTD 1996; Lokke 1984); however, rapid biodegradation is expected to limit the extent of leaching through soil (see Section 5.3.2.3). The compound may also volatilize from dry surface soils (EPA 1979, 1987a; Hine and Mookerjee 1975). In dry soils, ethylene glycol liquid can enter the soil system and travel through the porous media before contacting free water. Amoozegar et al. (1986) reported that in dry soils (<1% water), however, the rate of ethylene glycol movement was the slowest of 6 organic liquids tested (toluene, xylene, kerosene, acetone, and isopropyl alcohol).

Propylene glycol has a low vapor pressure (0.07 mm Hg at 20 °C) and is miscible with water (see Table 3-2). If released to the atmosphere (e.g., as vapors generated at elevated temperatures), propylene glycol should exist almost entirely in the vapor phase (Eisenreich et al. 1981). The high solubility of propylene glycol in water ensures at least partial removal of the compound will occur by wet deposition (EPA 1987a). Therefore, upon release to the environment, the compound is expected to be transported primarily in aqueous media (EPA 1979). The low Henry's law constant values for the compound (1.2×10^{-8} to 1.7×10^{-8} atm-m³/mole range; see Table 3-2) suggest that releases to surface water will not partition to the atmosphere via volatilization (Simmons et al. 1976; Thomas 1990). Adsorption to sediment or soil particulates is also not expected to be significant on the basis of the low K_{oc} value (see Table 3-2).

Based on the low K_{oc} value, propylene glycol is expected to have a very high mobility in soil and could leach into groundwater (Swann et al. 1983). The low octanol/water partition coefficient (K_{ow}) (see Table 3-2) suggests that bioconcentration and biomagnification are also not likely to occur. No measured BCF values were located for this compound.

Propylene glycol is expected to be highly mobile in moist soils and may leach to groundwater upon release to surface soils; however, rapid biodegradation is expected to limit the extent of the leaching (see Section 5.3.2) (EPA 1987a). The compound may also volatilize from dry surface soils (EPA 1979, 1987a; Hine and Mookerjee 1975).

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5.3.2 Transformation and Degradation

5.3.2.1 Air

Ethylene glycol released to the atmosphere is expected to undergo rapid photochemical oxidation via reaction with hydroxyl radicals. The half-life for the photochemical oxidation of ethylene glycol has been estimated to be 8-84 hours (EPA 1987a; Howard et al. 1991).

Propylene glycol released to the atmosphere is expected to undergo rapid photochemical oxidation via reaction with hydroxyl radicals. The half-life for the photochemical oxidation of propylene glycol has been estimated to be 20-32 hours (EPA 1987a; Howard et al. 1990).

5.3.2.2 Water

Biodegradation by a variety of acclimated and unacclimated microorganisms, under both aerobic and anaerobic conditions, is the most important transformation process for ethylene glycol in surface waters. Ethylene glycol is rapidly metabolized in aqueous solutions, as measured using five different biodegradation tests (Means and Anderson 1981). Other reports of biotransformation of ethylene glycol include metabolism by activated or anaerobic sewage sludge microorganisms (Battersby and Wilson 1989; Bieszkiewicz et al. 1979; Dwyer and Tiedje 1983; Watson and Jones 1977), river water microbes (Evans and David 1974), halophilic bacteria (Caskey and Taber 1981; Gonzalez et al. 1972), and pond water microbes (Child and Willetts 1978; Willetts 1981). For example, the biodegradation of ethylene glycol was complete in 3 days at 20 °C and in 14 days at 8 °C when it was added to river water at concentrations ≤ 10 mg/L (ppm) (Evans and David 1974).

Waste water carrying ethylene glycol could be purified by the activated sludge method providing the concentration of ethylene glycol did not exceed 1,000 mg/L (ppm) (Bieszkiewicz et al. 1979). Similar results were observed for the degradation of ethylene glycol in groundwater (McGahey and Bouwer 1992). At an initial substrate concentration of 111 mg/L (ppm), naturally occurring microorganisms in groundwater biodegraded ethylene glycol with an estimated half-life of < 1 day following a lag phase of < 3 days. Increased substrate (ethylene glycol) concentrations decreased the rate of biodegradation. At a substrate concentration of 10,000 mg/L (ppm), however, minimal substrate disappearance was

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observed, probably due to oxygen limitation in solution. Howard et al. (1991) estimated a half-life of 2-12 days for ethylene glycol under aerobic conditions and 8-48 days under anaerobic conditions.

Ethylene glycol is not expected to undergo significant abiotic transformation in surface waters via hydrolysis or oxidation (EPA 1979; Harris 1990; Howard et al. 1991). Glycols generally are resistant to hydrolysis (Harris 1990). However, photolysis of ethylene glycol sorbed to goethite (a common natural constituent of surface water sediments) by near ultraviolet radiation (300-400 nm) has been demonstrated in the laboratory. Formaldehyde and glycolaldehyde were detected as degradation products (Cunningham et al. 1985).

Biodegradation by a variety of acclimated and unacclimated microorganisms, under both aerobic and anaerobic conditions, is also the most important transformation process for propylene glycol in surface waters. The half-lives for the biotransformation of propylene glycol generally range from 1 to 4 days under aerobic conditions and from 3 to 5 days under anaerobic conditions (EPA 1987a).

Propylene glycol rapidly disappears from culture flasks containing activated sludge microorganisms under both aerobic and anaerobic conditions (Kaplan et al. 1982). Some propylene glycol was lost from sterile cultures after 9 days. An 8% and 16% loss of propylene glycol was observed in sterile anaerobic and aerobic cultures, respectively. In active cultures, propylene glycol was not detected after 2 days in aerobic nutrient broth. When used as a sole carbon source, propylene glycol disappeared after 4 days under aerobic and 9 days under anaerobic conditions. Raja et al. (1991) reported a novel biotreatment process using *Pseudomonas* and *Aerobacter* bacteria. The *Pseudomonas* were able to use the propylene glycol to produce volatile acids, while *Aerobacter* degraded the volatile acids quickly to carbon dioxide and water.

Propylene glycol is not expected to undergo significant abiotic transformation in surface waters via hydrolysis or oxidation (EPA 1979, 1987a). Glycols generally are resistant to hydrolysis (Harris 1990). For example, the half-life for reaction of propylene glycol with hydroxyl radicals in aqueous solution has been estimated to be 1.3-2.3 years (Harris 1990).

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5.3.2.3 Sediment and Soil

Biodegradation by a variety of microorganisms under both aerobic and anaerobic conditions is also the most important transformation process for ethylene glycol in soils, with a half-life similar to or less than that in surface waters (EPA 1987a). In a laboratory study, soil microbes of the genera *Pseudomonas*, *Citrobacter*, and *Serratia* degraded ethylene glycol, at solution concentrations of 1-3%, within 3 days; concentrations higher than 5% were toxic to the microbes (LDOTD 1990). The soil microbe *Clostridium glycolicum* degraded ethylene glycol under anaerobic conditions to acid and alcohol end products (Gaston and Stadtman 1963).

The rate of biodegradation of ethylene glycol in simulated subsurface soils are dependent on substrate concentrations, soil types, and ambient soil temperatures, but nutritional supplements had minimal effects (McGahey and Bouwer 1992). Greater than 95% removal was consistently accomplished in <5 days and 7 days at ethylene glycol concentrations of 100 ppm and 1,000 ppm, respectively; however, substrate concentrations of 10,000 ppm showed negligible loss of ethylene glycol. Soils with high organic matter, and thus enhanced microbial diversity and activity, also degraded ethylene glycol significantly faster. A doubling in the degradation rate was also observed with a 10 °C increase in soil temperature. McGahey and Bouwer (1992) concluded that microorganisms naturally occurring in soils and groundwater are effective in biodegrading ethylene glycol with the half-life ranging from 0.2 to 0.9 days. Klecka et al. (1993) studied the biodegradation of aircraft de-icing fluids in soils adjacent to airport runways at various ethylene glycol concentrations and at various temperatures ranging from -2 to 25 °C. Generally, the rate of biodegradation of ethylene glycol was faster in soils with low glycol concentrations, high organic carbon content, and higher ambient soil temperatures (in the range of -2 to 25 °C). Ethylene glycol present in soils at concentrations <6,000 mg/kg (ppm) biodegraded at an average rate of 3.0 mg/kg (ppm) soil /day at -2 °C, at 19.7 mg/kg (ppm) soil/day at 8 °C, and at an average rate of 66.3 mg/kg (ppm) soil/day at 25 °C (Klecka et al. 1993). Based on these results, biodegradation is expected to play a major role in removing ethylene glycol residues from soils adjacent to airport runways and taxiways.

As in surface waters, abiotic transformation of ethylene glycol in soil is not expected to be a significant process (EPA 1987a).

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Biodegradation by a variety of microorganisms under both aerobic and anaerobic conditions is also the most important transformation process for propylene glycol in soils, with half-lives similar to or less than those in surface waters (EPA 1987a). The soil microbe *C. glycolicum* degraded propylene glycol under anaerobic conditions to acid and alcohol end products (Gaston and Stadtman 1963). Ouattara et al. (1992) reported anaerobic degradation of propylene glycol by strains of the sulfate-reducing bacteria *Desulfovibrio* isolated from anoxic soil of a rice field. Propylene glycol was degraded to acetate in the presence of sulfate with the production of carbon dioxide. The rates of biodegradation of propylene glycol in soils are significantly dependent on substrate concentrations, soil types, and ambient soil temperatures, but nutritional supplements had minimal effects (Klecka et al. 1993). Generally, the rate of propylene glycol biodegradation was faster in soils with low glycol concentrations, high organic carbon content, and higher ambient soil temperatures (in the range of -2-25 °C). Propylene glycol present in soils at concentrations <6,000 mg/kg (ppm) biodegraded at an average rate of 2.3 mg/kg soil/day at -2 °C, 27.0 mg/kg (ppm) soil/day at 8 °C and at an average rate of 93.3 mg/kg (ppm) soil/day at 25 °C (Klecka et al. 1993). Based on these results, biodegradation is expected to play a major role in removing propylene glycol residues from soils adjacent to airport runways and taxiways.

As in surface waters, abiotic transformation of propylene glycol in soil is not expected to be a significant process (EPA 1987a).

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

5.4.1 Air

Ethylene glycol was detected in ambient air samples, at time-weighted average (TWA) concentrations of <0.05-0.33 mg/m³ as aerosol and <0.05-10.4 mg/m³ as vapor, following spray application of de-icing fluids containing 50% solutions of the compound to the surfaces of bridges. The ambient air samples were collected above the sprayed bridges (LDOTD 1990).

No information was located on the concentration of propylene glycol in the ambient atmosphere. Propylene glycol was detected in air samples collected in a large scale environmental chamber analyzing volatile organic emissions. Quasi-steady-state emission rates of the propylene glycol at

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24 hours and 168 hours after the start of the experiment were $690 \mu\text{g}/\text{m}^2/\text{hour}$ and $193 \mu\text{g}/\text{m}^2/\text{hour}$, respectively from newly installed carpet with polyvinylchloride backing (Hodgson et al. 1993).

5.4.2 Water

Available information on the environmental impact of de-icing solutions on airport storm water runoff has been summarized in a recent review article by Sills and Blakeslee (1992). Monitoring data from several contractor and airport authority reports reveal that storm water runoff from airports may contain several hundred to several thousand mg/L (ppm) glycols. Ethylene glycol levels up to 19,000 mg/L (ppm) were detected in storm water from the Salt Lake City International Airport. The concentration of ethylene glycol in runoff from runway apron areas at the Toronto International Airport ranged from 75.0 mg/L to 3,100 mg/L (ppm) and was up to 70 mg/L (ppm) in a stream that received runoff from the airport. The concentration of ethylene glycol in storm water runoff from Stapleton International Airport in Denver, Colorado ranged from near zero to 5,050 mg/L (ppm). Although the potential for groundwater contamination is quite low for many airports with predominantly heavy soil, the movement of glycols through unsaturated silty sand can be potentially high (Sills and Blakeslee 1992). Thus, although ethylene glycol was not detected even in shallow soils at the edge of the runway at the Stapleton International Airport, the groundwater in the perched water table at Ottawa International Airport in Canada, which contained sandy soil, was found to contain ethylene glycol at levels up to 415 mg/L (ppm). Peak concentrations occurred in June and declined to nondetectable levels by the fall.

Available information on the environmental impact of de-icing solutions on airport storm water runoff has been summarized in a recent review article by Sills and Blakeslee (1992). Monitoring data from several contractor and airport authority reports reveal that storm water runoff from airports may contain several hundred to several thousand mg/L (ppm) glycols. Propylene glycol levels up to 19,000 mg/L (ppm) were detected in storm water from the Salt Lake City International airport. Although the potential for groundwater contamination is quite low for many airports with predominantly heavy soil, the movement of glycols through unsaturated silty sand can be potentially high (Sills and Blakeslee 1992). At the Ottawa International Airport in Canada, groundwater in the perched water table, which contained sandy soil, was found to contain propylene glycol at levels up to 4 mg/L (ppm). Peak concentrations occurred in June and declined to nondetectable levels by the fall.

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5.4.3 Sediment and Soil

No information was found on soil concentrations of ethylene glycol or propylene glycol.

5.4.4 Other Environmental Media

Ethylene glycol has been identified in negligible amounts in the water-soluble component of cigarette smoke (Schumacher et al. 1977).

Ethylene glycol has been found to migrate into a number of foods from regenerated cellulose films containing triethylene glycol and polyethylene glycol as softening agents. Ethylene glycol was detected in fruit cakes at 27-34 mg/kg (ppm) after 84-336 days of storage, in meat pies at <10 mg/kg (ppm) after 3-7 days of storage, in toffee at <10-22 mg/kg (ppm) after 168-450 days of storage, in madeira cake at <10-22 mg/kg (ppm) after 21-28 days storage, and in boiled sweets at 14-34 mg/kg (ppm) after 168-450 days storage (Castle et al. 1988a). Ethylene glycol also has been found to migrate into food simulants from polyethylene terephthalate (PET) bottles used in the packaging of carbonated beverages. The compound was detected at a concentration of about 100 ppb (0.1 ppm) in a 3% acetic acid solution used as a food simulant after 6 months of storage at 32 °C (Kashtock and Breder 1980). The source of ethylene glycol in this food simulant is the small amount of unreacted ethylene glycol in the polyethylene terephthalate polymer.

Propylene glycol have been identified in negligible amounts in the water-soluble component of cigarette smoke (Schumacher et al. 1977).

Propylene glycol has also been found to migrate into a number of foods from regenerated cellulose films containing the compound as a softening agent. The compound was detected in chocolates at 20-1,460 mg/kg (ppm) after 5.5 months of storage and at 25-1,890 mg/kg (ppm) after 15 months, in fruit cakes at 10-154 mg/kg (ppm) after 84-336 days of storage, in meat pies at <10-118 mg/kg (ppm) after 3-7 days of storage, in toffee at <10-1,530 mg/kg (ppm) after 168-450 days of storage, in madeira cake at <10-365 mg/kg (ppm) after 21-28 days storage, and in boiled sweets at <10-272 mg/kg (ppm) after 168-450 days storage (Castle et al. 1988a).

Propylene glycol is also used in some cosmetic and oral drug formulations and is a GRAS additive in foods (FDA 1982), where it is used as an emulsifying and plasticizing agent, humectant, surfactant,

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and solvent. Propylene glycol is added to foods at concentrations ranging from <0.001% in eggs and soups to up to 97% in seasonings and flavors (EPA 1979). Propylene glycol is a naturally occurring by-product in the fermentation of some beers and has been detected in the concentration range of 1.0-51.0 mg/L (ppm) in several commercially packaged beers (Williamson and Iverson 1993).

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

The most important route of human exposure to ethylene glycol for members of the general population is dermal contact with fluids used in automobiles (e.g., antifreeze, coolants, brake fluids). However, intentional or accidental ingestion of antifreeze by children and adults has caused the most morbidity and mortality in the past.

The National Occupational Exposure Survey (NOES) conducted by NIOSH during 1981-83 estimated 1.5 million workers are potentially exposed to ethylene glycol each year (NIOSH 1990). Contact with the skin and eyes is the most likely route of worker exposure to ethylene glycol. Inhalation may be an important route of human exposure under occupational conditions where the compound is heated or if mists are generated by heat or violent agitation (Rowe and Wolf 1982). Air samples taken from the breathing zones of workers applying de-icing fluids (50% ethylene glycol) to bridge surfaces contained the compound at concentrations of <0.05-2.33 mg/m³ as aerosols and <0.05-3.37 mg/m³ as vapors (LDOTD 1990).

The general population is exposed to propylene glycol primarily through ingestion of food and pharmaceutical products and through dermal contact with cosmetic products containing the compound (EPA 1979, 1987a). The average daily dietary intake of propylene glycol in Japan, where the compound is used as a food additive stabilizer, was estimated to be 43 mg per person in 1982 (Louekari et al. 1990). Public school children and the general public who participate in fire fighting exercises/demonstrations where propylene glycol is used to simulate fire conditions are exposed to small amounts of propylene glycol (Ross01 1993). The general public is exposed to low concentrations of propylene glycol mist from propylene glycol-containing theatrical fog/smoke used in producing special effects during theatrical performances, rock concerts, and private parties (Ross01 1993). The general public is also exposed to small concentrations of propylene glycol from carpets with polyvinyl chloride backing. The quasi-steady-state specific emission rate of propylene glycol

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from these carpets was calculated to be 690 $\mu\text{g}/\text{m}^2/\text{hour}$ at 24 hours and 193 $\mu\text{g}/\text{m}^2/\text{hour}$ at 168 hours after carpet installation (Hodgson et al. 1993).

NOSH estimated that about 2.5 million individuals were potentially exposed to propylene glycol in the workplace in 1970; the estimate for 1980 was 80,200 workers (HSDB 1995b). Dermal contact is expected to be the main route of worker exposure; however, inhalation of vapors or mists may also occur when the compound is heated, agitated, or sprayed (e.g., in de-icing formulations) (Rowe and Wolf 1982).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Workers in industries involved in the manufacture or use of products containing high concentrations of ethylene glycol (e.g., antifreeze, coolants, de-icing fluids, brakes fluids, solvents) may be exposed to concentrations of the compound at levels higher than the general population, particularly in operations involving heating or spraying of these materials.

Members of the general population who currently have potentially high exposures to ethylene glycol include individuals living near sites where ethylene glycol is manufactured or used, and individuals living near waste disposal sites contaminated with ethylene glycol. Persons living near airports where large amounts of ethylene glycol are used for de-icing of aircraft or near hazardous waste sites are potentially at greater risk of exposure, particularly from consumption of contaminated groundwater.

Workers in industries involved in the manufacture or use of products containing high concentrations of propylene glycol (e.g., antifreeze, coolants, de-icing fluids, brakes fluids, solvents) may be exposed to concentrations of the compounds at levels higher than the general population, particularly in operations involving heating or spraying of these materials. Performers and workers in theatrical productions that use propylene glycol-containing fog/smoke for special effects are likely to be exposed to higher concentrations of propylene glycol than the general population (Ross01 1993). Fire fighters who participate in frequent fire-fighting exercises involving propylene glycol fog/smoke may also belong to the high exposure group (Rosso1 1993).

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5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of ethylene glycol and propylene glycol is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of ethylene glycol and propylene glycol.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Identification of Data Needs

Physical and Chemical Properties. As seen in Table 3-2, the relevant physical and chemical properties of ethylene glycol are known (Daubert and Danner 1989; HSDB 1995a; Merck 1989; Rowe and Wolf 1982; Weast 1988) and predicting the environmental fate and transport of ethylene glycol based on the K_{ow} , K_{oc} , and Henry's law constant is possible. No further information is required.

As seen in Table 3-2, the relevant physical and chemical properties of propylene glycol are known (ASTER 1995b; Daubert and Danner 1989; EPA 1987a; HSDB 1995b; Merck 1989) and predicting the environmental fate and transport of ethylene glycol based on the K_{ow} , K_{oc} , and Henry's law constant is possible. No further information is required.

Production, Import/Export, Use, Release, and Disposal. Knowledge of production and use data for a chemical is important in predicting its potential for environmental contamination and human exposure. Recent production data are available for ethylene glycol (SRI 1989, 1991, 1993). Similarly, data on the import/export volumes for ethylene glycol for the last several years are available (NTDB 1995). Information on the various uses of this compound are also available (Browning 1965; HSDB 1995a; Lewis 1993; Merck 1989; Rowe and Wolf 1982). Ethylene glycol enters the environment

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primarily during its use as an ingredient in hydraulic brake fluids, as a component of automotive antifreeze/coolants, as a de-icing fluid for aircraft, and in its use as an intermediate in the synthesis of polyester fibers (Klecka et al. 1993; Lewis 1993; Merck 1989; Rowe and Wolf 1982). Major sources of ethylene glycol releases to soils are from the disposal of used antifreeze and de-icing solutions in hazardous waste sites (EPA 1979, 1987a; Ware 1988). Information regarding the disposal of ethylene glycol-containing waste waters (Rice et al. 1993; Wang et al. 1993) and for remediation of ethylene glycol contaminated soils (Drajun 1991; Vesper et al. 1994) is available.

According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxics Release Inventory (TRI), which contains this information for 1988-1993, became available in May of 1995. This database will be updated yearly and should provide a list of industrial facilities and emissions. TRI data are available for ethylene glycol because this chemical is required to be reported by chemical producers (EPA 1995c).

Recent production data are available for propylene glycol (SRI 1989, 1991, 1993, 1995). Similarly, data on the import/export volumes for propylene glycol for the last several years are available (NTDB 1995). Information on the various uses of this compound are also available (EPA 1987a; HSDB 1995b; Lewis 1993; Merck 1989; Rowe and Wolf 1982). Propylene glycol enters the environment primarily during its use as an intermediate in the synthesis of polyester fibers and resins, as a component of automotive antifreeze/coolants, and as a de-icing fluid for aircraft (Kirk-Othmer Encyclopedia of Chemical Technology 1978; Klecka et al. 1993; Lewis 1993; Merck 1989; Rowe and Wolf 1982). Propylene glycol is also used in pharmaceutical products, hair colorant formulations, food and tobacco products, as a non-toxic antifreeze in the food industry, as an air sterilant in hospitals or animal facilities, and as a special effects fog/smoke in theatrical performances or in fire training programs (Kirk-Othmer Encyclopedia of Chemical Technology 1978; Klecka et al. 1993; Merck 1989; Ross01 1993; Rowe and Wolf 1982). Information regarding the disposal of propylene glycol-containing waste waters (Chou et al. 1979; Raja et al. 1991) and for remediation of propylene glycol contaminated soils (Drajun 1991; Vesper et al. 1994) is available.

According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxics Release Inventory (TRI), which contains this information for 1988-1993,

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became available in May of 1995. This database will be updated yearly and should provide a list of industrial facilities and emissions. No TRI data are available for propylene glycol because this chemical is not required to be reported by chemical producers (EPA 1995c).

Environmental Fate. Information regarding the fate of ethylene glycol in the air is available that suggests the compound would be primarily found in the vapor phase and would likely be removed from the atmosphere via wet deposition (Eisenreich et al. 1981; EPA 1979). Ethylene glycol undergoes rapid photochemical oxidation via reaction with hydroxyl radicals with an estimated half-life of 8-84 hours (EPA 1987a; Howard et al. 1991). Because of its high solubility in water, the compound is expected to be transported primarily in aqueous media (EPA 1979) and will not partition to the atmosphere via volatilization from water (Thomas 1990). Adsorption to sediment or soil particles is not expected to be significant based on the low K_{oc} value; therefore, ethylene glycol is expected to have a high mobility in soil and potential to leach into groundwater (Swarm et al. 1983). Ethylene glycol is degraded in both water (Battersby and Wilson 1989; Bieszkiewicz et al. 1979; Caskey and Taber 1981; Child and Willetts 1978; Dwyer and Tiedje 1983; Evans and David 1974; Gonzalez et al. 1972; Watson and Jones 1977; Willetts 1981) and soil (EPA 1987a; Gaston and Stadtman 1963; LDOTD 1990; Klecka et al. 1993; McGahey and Bouwer 1992) primarily by biodegradation. Howard et al. (1991) estimated a half-life of 2-12 days for ethylene glycol in surface water under aerobic conditions and 8-48 days under anaerobic conditions, while the half-life of ethylene glycol in soil due to biodegradation was estimated to be 0.2-0.9 days. No additional information on degradation of ethylene glycol in air, water or soil are required.

Information regarding the fate of propylene glycol in the air is available that suggests the compound would be primarily found in the vapor phase and would likely be removed from the atmosphere via wet deposition (Eisenreich et al. 1981; EPA 1979, 1987a). Propylene glycol undergoes rapid photochemical oxidation via reaction with hydroxyl radicals with an estimated half-life of 20 hours in the atmosphere (EPA 1987a). Because of its high solubility in water, the compound is expected to be transported primarily in aqueous media and will not partition to the atmosphere via volatilization from water (EPA 1979, 1987a; Thomas 1990). Adsorption to sediment or soil particles is not expected to be significant based on the low K_{oc} value and therefore propylene glycol is expected to have a high mobility in soil and potential to leach into groundwater (Swarm et al. 1983). Propylene glycol is transformed in both water and soil by microorganisms (EPA 1987a; Gaston and Stadtman 1963; Klecka et al. 1993). The half-lives for the biotransformation of propylene glycol in surface waters

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generally range from 1 to 4 days under aerobic conditions and from 3 to 5 days under anaerobic conditions, with half-lives in soil similar to or less than those in surface waters (EPA 1987a). No additional information on degradation of propylene glycol in air or water are required; however, additional quantitative information on the degradation of propylene glycol in soil would be useful.

Bioavailability from Environmental Media. Available information regarding the rate of ethylene glycol absorption following inhalation, oral, or dermal contact has been discussed in the Toxicokinetics section (see Section 2.3). Although no data on ethylene glycol's bioavailability from contaminated air are available, the bioavailability from inhalation exposure is expected to be high because ethylene glycol is likely to be present in the vapor phase (Eisenreich et al. 1981) and not in the particulate phase in the adsorbed state. Similarly, no data on the bioavailability of ethylene glycol from water, soil or plant material are available; however, ethylene glycol is readily miscible in water and does not adsorb readily to soil. Ethylene glycol, therefore, is expected to be readily bioavailable from soil and water. Information on the bioavailability of ethylene glycol from actual environmental media needs further development.

Reliable monitoring data for the levels of ethylene glycol in contaminated media at hazardous waste sites are needed so that the information obtained on levels of ethylene glycol in the environment can be used in combination with the known body burdens of ethylene glycol to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Available information regarding the rate of propylene glycol absorption following inhalation, oral, or dermal contact has been discussed in the Toxicokinetics section (see Section 2.3). Although no data on propylene glycol's bioavailability from contaminated air are available, the bioavailability from inhalation exposure is expected to be high because propylene glycol is likely to be present in the vapor phase (Eisenreich et al. 1981) and not in the particulate phase in the adsorbed state. Similarly, no data on the bioavailability of propylene glycol from water, soil or plant material are available; however, propylene glycol is readily miscible in water and does not adsorb readily to soil. Propylene glycol, therefore, is expected to be readily bioavailable from soil and water. Information on the bioavailability of propylene glycol from actual environmental media is not required as propylene glycol is a GRAS chemical (FDA 1982).

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Because the FDA (1982) has classified propylene glycol as a GRAS chemical, no monitoring data for concentrations of propylene glycol in contaminated media at hazardous waste sites are needed to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Food Chain Bioaccumulation. Based on its low K_{oc} value, ethylene glycol is not expected to bioconcentrate in aquatic food chains. In laboratory exposure studies, ethylene glycol does not bioconcentrate to any great extent in fish, crayfish, or algae (Freitag et al. 1985; Khoury et al. 1993); however, measured BCF values are not available for a large number of edible invertebrate and fish species. Information is also lacking regarding the biomagnification potential of ethylene glycol through aquatic food chains although biomagnification is probably a minor process because of the rapid degradation rate for the chemical in aquatic systems. No further information on the bioconcentration or biomagnification potential of ethylene glycol are required.

Based on its low K_{oc} value, propylene glycol is not expected to bioconcentrate in aquatic food chains; however, no measured BCF values were located for any invertebrate or fish species. Information is also lacking regarding the biomagnification potential of propylene through aquatic food chains although it is unlikely because of the rapid degradation rate for the chemical in aquatic systems. No further information on the bioconcentration or biomagnification potential of propylene glycol is required as it is a GRAS chemical (FDA 1982).

Exposure Levels in Environmental Media. Little quantitative information was located on the concentration of ethylene glycol in ambient air. TWA concentrations of the compound as both an aerosol and a vapor were measured following the spray application of de-icing fluids containing ethylene glycol on a bridge (LDOTD 1990). These data are not general enough to estimate inhalation exposure to ethylene glycol for the general population in the United States. Ethylene glycol was detected in air samples collected at four hazardous waste sites (HazDat 1995). No data on the level of ethylene glycol in drinking water were located, although ethylene glycol has been detected at up to 415 mg/L (ppm) in groundwater in the vicinity of an airport (Sills and Blakeslee 1992) and in groundwater samples collected at 7 hazardous waste sites (HazDat 1995). Little information on the levels of ethylene glycol in soils was located. Ethylene glycol was detected in a soil sample collected (at an unspecified depth) at one hazardous waste site (HazDat 1995). Additional information regarding the levels of ethylene glycol in ambient air, in drinking water, and in soil is needed. Some data on

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ethylene glycol levels in foods, particularly those stored in cellulose films or in PET bottles are available (Castle et al. 1988a; Kashtock and Breder 1980). Additional quantitative information on current levels of ethylene glycol in various environmental media and levels of contamination in foods would be helpful in assessing the health risks to the general population and in occupational settings.

Reliable monitoring data for the levels of ethylene glycol in contaminated media at hazardous waste sites are needed so that the information obtained on levels of this compound in the environment can be used in combination with the known body burden of ethylene glycol to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

No information was located on the concentration of propylene glycol in ambient air. Propylene glycol was detected in air samples collected in a large scale environmental chamber analyzing volatile organic emissions from newly installed carpet with polyvinylchloride backing (Hodgson et al. 1993). No data on the level of propylene glycol in drinking water were located, although propylene glycol has been detected at up to 4 mg/L (ppm) in groundwater in the vicinity of an airport (Sills and Blakeslee 1992) and at unspecified concentrations in groundwater samples collected at two hazardous waste sites (HazDat 1995). Little information on the levels of propylene glycol in soils was located. Data on propylene glycol levels in foods, particularly those stored in cellulose films or in PET bottles, are available (Castle et al. 1988a; EPA 1979; Kashtock and Breder 1980; Williamson and Iverson 1993) and a recent estimate of human dietary intake of propylene glycol in Japan is available (Louekari et al. 1990). Reliable monitoring data for the levels of propylene glycol in various environmental media are not needed as this compound is a GRAS additive in foods (FDA 1982).

Exposure Levels in Humans. Little quantitative information on ethylene glycol levels in various human tissues and body fluids of a control population, populations near hazardous waste sites, or occupationally exposed groups in the United States is available. Most information is available for oral exposures derived from intentional or accidental poisonings (Gabow et al. 1986; Hewlett et al. 1986; Jacobsen et al. 1988; Parry and Wallach 1974; Robinson and McCoy 1989; Vale 1979; Wiener and Richardson 1988). Some information is available on plasma glycolate levels for poisoning victims admitted to a hospital (Jacobsen et al. (1984), and on urine and other tissues (Cheng et al. 1987; Rothman et al. 1986; Winek et al. 1978). Data are needed on the levels of ethylene glycol and its metabolites in body tissues and fluids especially from dermal and inhalation studies. Information on control populations, populations that live in the vicinity of hazardous waste sites, and those who are

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occupationally exposed to ethylene glycol is needed. This information is necessary for assessing the need to conduct health studies on these populations.

Little quantitative information on propylene glycol levels in various human tissues and body fluids of a control population, populations near hazardous waste sites, or occupationally exposed groups in the United States is available. Most information is available for oral exposures (Yu et al. 1985). Data on the levels of propylene glycol and its metabolites in body tissues and fluids are not needed because this chemical is a GRAS food additive (FDA 1982).

Exposure Registries. No exposure registries for ethylene glycol were located. This substance is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

No exposure registries for propylene glycol were located. This substance is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

5.7.2 Ongoing Studies

No additional information was located on ongoing studies that would fill existing data needs for ethylene glycol or propylene glycol (FEDRIP 1995).